REMARKS

Claims 22-83 and 87 have been previously withdrawn from consideration and canceled from the present application. Claims 15 and 16 have been previously cancelled. Claims 88-94 were previously added.

Claim 4 has been cancelled. Claims 95-99 are new. Claims 1, 9, 10, 11, 91, 93, 94 have been amended. The claims remaining in the application are 1-3, 5-14, 17-21, 85, 86, and 88-94.

Specification:

In response to the Office Action's objection to the specification, the image-bearing beam previously included in the Specification is now numbered "47". The Parts List is also corrected accordingly, along with Figures 1 and 2 which had shown the image-bearing beam, but had not previously labeled it as such.

Rejection Under 35 U.S.C. § 112

The Office Action has rejected claims 1, 91, and 93-94 under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. This rejection is respectfully traversed.

The Office Action has noted an apparent contradiction between the "image-carrying monochromatic beam" and "beam of multicolor light" of the present invention. The inventor had recognized this possible awkwardness of terminology and attempted to define the use of the term monochromatic as applied to the apparatus and method of the present invention. This description, along with an explanation of the somewhat confusing term "grayscale," is in the Detailed Description on page 7 of the specification. The rationale for considering monochromatic or grayscale images in medical diagnostic imaging is briefly summarized in the Background section of the present application, page 2. As noted in the present application, a base color hue is often used to represent various types of diagnostic images. This use of a single hue for this purpose is closely analogous to our conventional use of grayscale images that use only shades of a single hue: black. Even though the hue is used as if it were a "pure" color, it must, in fact, be synthesized using some combination of component colors,

typically red, green, and blue (RGB). The composition of a single color hue from pure colors is well known in the imaging arts, both for printing and display.

Conventional X-rays are a case in point. Often, X-rays processed conventionally have a dark bluish tint and provide images wherein tonal shades of this same blue hue represent bone structures. In effect, the specialist examining an X-ray is looking at a "grayscale" image, where the single hue that is varied in tone is typically a dark blue. It is noteworthy that different X-ray equipment produces images using different "grayscale" tones, most often in a range of blue colors. It is a goal of the present invention to allow a practitioner to display such images electronically and vary the "grayscale" hue on the display, so that the film version of the same image would have the same appearance as the displayed version.

Recognizing the difficulty pointed out by the Office Action in this objection, claims 1, 9, 10, 91, 93, and 94 have been amended to replace the "monochrome" language with language indicating use of tone values of a single color hue for imaging.

Rejection Under 35 U.S.C. § 103

The Office Action has rejected claims 1-4, 6-7, 9-10, 18-19, 84-86, and 91 under 35 U.S.C. 103(a) as being unpatentable over Richards (U.S. Patent No. 6,388,661 B1) in view of Konno et al. (U.S. Patent No. 5,327,229). This rejection is respectfully traversed.

The Richards '661 disclosure is directed to the use of a digital micromirror spatial light modulator (SLM) device that modulates light using a two-dimensional array of micromirrors, each micromirror rapidly toggled into either of two positions in order to direct light of a variable brightness level to a display surface. As the Office Action has pointed out, the Richards '661 disclosure shows the modulation of a multicolor light source, provided using a color filter wheel, to provide an image. However, there are significant differences between the digital micromirror device used in the Richards '661 apparatus and any type of SLM that requires a bias voltage, V_{bias}. It must be emphasized that the basic component of the digital micromirror device, at the pixel level, is a binary micromirror that is positionally switched into either of two modes: either reflecting (logic "1") or non-reflecting (logic "0") and has no intermediate state

between these modes that can be used for imaging. Variable brightness for a pixel is achieved by varying the proportion of reflecting time versus non-reflecting time. Hence, the detailed description of pulse-width modulation (PWM) techniques in the Richards '661 disclosure, since this type of modulation technique is ideally suited to the binary actuation and modulation of the digital micromirror device.

Unlike the binary pixel of the PWM-controlled digital micromirror device in the Richards '661 disclosure, the liquid-crystal (LC) SLM of the embodiment claimed in claims 1 and following modulates light by a polarization shift. By comparison with this binary modulation, modulation of polarization allows continuous or "analog" brightness modulation. One key factor in controlling the degree of modulation for the LC pixel is the bias voltage V_{bias} applied to the SLM. There is no bias voltage needed or used with the digital micromirror device of the Richards '661 apparatus. Moreover, there is no suggestion provided in the Richards '661 disclosure for a display device intended to display an image using tonal values of a single hue.

Turning to the apparatus disclosed in the Konno '229 patent, a distinction must be made between two different types of liquid-crystal SLMs: optically addressable (OASLM), as shown in the Konno '229 disclosure, and electrically addressable (EASLM), as described in the apparatus of the present invention. In the optically addressable SLM, a CRT or similar display type is used to provide a writing light to the SLM. The modulated image, that is, the image on the CRT, is re-imaged onto the back surface of the LC SLM to form the image thereon. Then, a separate reading light is directed onto the front surface of the LC SLM and is modulated thereon. This reading light then provides the source light for display projection. Description of various SLM types, including this optically addressable SLM is included, for example, in U.S. Patent No. 5,903,323 (Ernstoff et al.); U.S. Patent No. 6,654,156 (Crossland et al.) describes the use of an EASLM to provide writing light to an OASLM. U.S. Patent No. 6,338,649 (Tanaka et al.) discloses an application using an OASLM display.

While the OASLM such as Konno '229 discloses may have a few advantages over the EASLM, such as a large spatial bandwidth, for example, there are considerable disadvantages in size, complexity, and cost of the OASLM. The use of a CRT, for example, introduces significant complexity, weight,

reliability, cost, and size concerns that can prevent the OASLM from being considered as a practical imaging alternative in many applications.

The EASLM of the present invention, as shown in Figures 1, 2, 5, 7, and 8, is a device of more recent development. As the term implies, individual pixel sites on the EASLM are electronically addressed, eliminating any need for a separate "writing light" from a CRT. Instead, the state of each electronically addressed pixel is electronically modulated according to image data. Then, the light source reflected from or transmitted through the EASLM is modulated accordingly. Unlike with the Konno '229 approach, changing the voltage bias provided to the EASLM in the present invention impacts not only the brightness of the output display, but also affects the modulation response of the device itself.

Thus, it can be seen that both the Richards '661 and Konno '229 apparatus differ significantly from each other in significant ways, including modulation type, operation, pixel addressing, and polarization requirements. Certainly, there are common problems to electronic display devices in providing source illumination that is to be modulated and in projecting the modulated light beam once it is formed. However, at the heart of the projection apparatus, where the incident illumination beam is modulated to provide imaging light, digital micromirror, OASLM, and EASLM devices all differ significantly from each other. There would be no motivation for a designer implementing a digital micromirror-based display to adapt approaches and techniques needed for apparatus that use OASLM light modulation. Conversely, a designer working with OASLM technology would have no motivation to turn to solutions employed for light modulation with digital micromirror components. Moreover, neither the digital micromirror device technology nor the OASLM technology is similar to the EASLM technology in this key aspect of image formation. Thus, in practice, there would be little motivation to combine the teaching of the Richards '661 and Konno '229 patents for any imaginable embodiment, since their imaging devices and modulation techniques differ so pronouncedly.

It must be noted that this same argument in response to any combination of Richards '661 and Konno '229 disclosures also applies to subsequent objections made to claims 2, 5, 20, 8, 11, 12, 13, 14, 17, 88 – 90, 92, 93, 94. Further responses for Office Action objections to these various claims follow.

The Office Action has rejected claims 2 and 4 under 35 U.S.C. 103(a) as being unpatentable over Richards and Konno et al. as applied to claim 1 above, and further in view of Tanaka et al. (U.S. Patent No. 6,388,649 B1). For claim 2, this rejection is respectfully traversed.

The Tanaka et al. disclosure, as was noted above, also describes an OASLM-based display in which a separate CRT writes the image to the photoconductive surface of the OASLM. As was noted with respect to the Konno '229 apparatus, there would be no motivation for adapting combined OASLM and digital micromirror device techniques to EASLM modulation, particularly where bias voltage to the device is modulated.

It must also be observed that item 2103 in Figure 21 of the Tanaka et al. '649 disclosure is a reflective LCD type of OASLM, not a digital micromirror device.

The Office Action has rejected claims 5 and 20 under 35 U.S.C. 103(a) as being unpatentable over Richards and Konno et al. as applied to claim 1 above, and further in view of Dawson (Pub. No. US 2002/0021832 A1). This rejection is respectfully traversed.

While the Dawson '1832 disclosure notes the use of variable birefringence polarized interference filters in stereoscopic 3-D imaging applications, this use of such devices is not analogous to the use of variable filter 28 as shown in Figures 1, 2, 4, and 5 of the present application. The Dawson '1832 apparatus uses the variable birefringence polarized interference filter to provide a separate image to each right and left eye for stereo viewing. Certainly, the use of a variable birefringence polarized interference filter could be considered at some point in the optics path for the display apparatus of the present invention; however, there is no disclosure within the present invention that is directly related to 3-D stereoscopic imaging applications. Variable filter 28 in the present invention is used to provide multicolor light. Thus, there would be no motivation for combining the teachings of Dawson '1832 with those of Richards '661 and Konno '229.

The Office Action has rejected claim 8 under 35 U.S.C. 103(a) as being unpatentable over Richards and Konno et al. as applied to claim 1 above, and further in view of Eaton (U.S. Patent No. 4,876,608). This rejection is respectfully traversed.

The Eaton '608 disclosure relates to a charge-retentive surface for forming a latent image within a xerographic printing apparatus in which toner is applied to a medium. The present invention, as described in the specification and claimed in claim 8, discloses the use of an image-retentive display surface or screen. There would be no reason for incorporating the teaching of the Eaton '608 disclosure in a display apparatus.

The Office Action has rejected claim 11 under 35 U.S.C. 103(a) as being unpatentable over Richards and Konno et al. as applied to claim 1 above, and further in view of Berlin (U.S. Patent No. 5,815,303). This rejection is respectfully traversed.

The Berlin '303 patent discloses a two-dimensional light modulator array that can be scanned across an imaging array on a fixed substrate to form an image and provides a method for fault compensation of one or more pixels in the two dimensional light modulator or imaging array. Rapid oscillation using piezoelectric actuators is one method used for compensating for failed pixels, shifting other pixel modulators into the spatial position of the faulted pixel. In addition, the Berlin '303 disclosure teaches that the brightness level of incident illumination can itself be increased to compensate for failed pixels or groups of pixels. However, the localized light intensity control indicated in the Berlin '303 disclosure is controlled based on the identified locations of one or more individual faulted pixels. In the present invention, on the other hand, overall light intensity is adjustable for achieving the proper image hue and overall brightness. Moreover, the intensity control of the present invention is accessible to the operator, rather than computed internally to the imaging support circuitry. There is thus little similarity between the type of intensity adjustment noted in the Berlin '303 patent and the type of operator intensity adjustment described in the specification of the present application and claimed in claim 11, as amended.

The Office Action has rejected claim 12 under 35 U.S.C. 103(a) as being unpatentable over Richards and Konno et al. as applied to claim 1 above, and further in view of Washburn (U.S. Patent No. 5,585,691). This rejection is respectfully traversed.

The apparatus of the Washburn '691 disclosure includes a potentiometer that can be tuned to adjust hue for a conventional CRT-based display. However, there is no indication in the Washburn '691 teaching that this

hue adjustment is accessible to an operator or viewer. Unlike the component shown in the Washburn '691 patent, the hue adjustment in claim 12 of the present application is specifically identified as an operator control. Certainly, operator controls for CRT hue adjustment are known. However, unlike conventional CRT hue adjustments, whether operator- or technician-accessible, the present invention claims an operator hue adjustment control for a display apparatus that provides a monochromatic image with tone values of a single hue, formed from multicolor light using a spatial light modulator with bias voltage controlled.

The Office Action has rejected claim 13 under 35 U.S.C. 103(a) as being unpatentable over Washburn, Richards and Konno et al. as applied to claim 12 above, and further in view of Wang (U.S. Patent No. 6,278,540 B1). This rejection is respectfully traversed.

The Wang '540 disclosure relates to optical filters and variable beam steering, particularly with respect to a tunable color filter. The SLM in the Wang '540 descriptions is shown as a likely component for providing the source beam to the tunable color filter. (In the Wang '540 patent, compare white light 250 in Figure 2 with 422 in Figure 4.) Of interest in Figure 10 [sic], items 1010A, 1010B and column 9, lines 8-22 is a beam scanner, for which externally applied control signals bias individual electro-optic layers to adjust reflectivity levels.

In contrast, claim 13 of the present invention relates to controlling bias voltage provided to the spatial light modulator. There is no suggestion in the Wang '540 disclosure that bias adjustment be provided for the SLM.

The Office Action has rejected claim 14 under 35 U.S.C. 103(a) as being unpatentable over Washburn, Richards and Konno et al. as applied to claim 12 above, and further in view of Wang (U.S. Patent No. 6,278,540 B1). This rejection is respectfully traversed.

The Wang '540 disclosure shows one possible method for controlling the intensity of a scanning beam. The Berlin '303 disclosure teaches that the brightness level of incident illumination can itself be increased to compensate for failed pixels or groups of pixels. However, the localized light intensity control indicated in the Berlin '303 disclosure is controlled based on the identified locations of one or more individual faulted pixels. In the present invention, on the other hand, as claimed in claim 14, the overall light intensity is adjustable for achieving the proper image hue. Moreover, the intensity control of

the present invention is accessible to the operator, rather than computed internally to the imaging support circuitry. Thus, no combination of Wang '540, Berlin '303, Washburn, Richards, and Konno et al. disclosures shows or suggests operator control of light source intensity in a display apparatus that provides a monochromatic image with tone values of a single hue, formed from multicolor light using a spatial light modulator with bias voltage controlled.

The Office Action has rejected claim 17 under 35 U.S.C. 103(a) as being unpatentable over Richards and Konno et al. as applied to claim 1 above, and further in view of Patel et al. (U.S. Patent No. 4,935,820). This rejection is respectfully traversed.

The Patel et al. '820 patent discloses the use of an interchangeable color filter in a printing apparatus for writing onto a photographic medium. No combination of Patel et al. '820, Richards, and Konno et al. disclosures shows or suggests the use of interchangeable filters in a display apparatus that provides a monochromatic image with tone values of a single hue, formed from multicolor light using a spatial light modulator with bias voltage controlled.

The Office Action has rejected claims 88-90, 92, 93, and 94 under 35 U.S.C. 103(a) as being unpatentable over Richards and Konno et al. as applied to claim 1 above, and further in view of Krasieva et al. (U.S. Patent No. 5,734,498). This rejection is respectfully traversed.

The Krasieva et al. '498 patent describes the use of various color-compensating filters in a conventional light microscope. However, no combination of the Krasieva et al. '498 teachings with the Richards and Konno et al. disclosures shows or suggests the use of interchangeable filters in a display apparatus that provides a monochromatic image with tone values of a single hue, formed from multicolor light using a spatial light modulator with bias voltage controlled.

CONCLUSION

Dependent claims not specifically addressed add additional limitations to the independent claims, which have been distinguished from the prior art and are therefore also patentable.

In conclusion, none of the prior art cited by the Office Action discloses the limitations of the claims of the present invention, either individually or in combination. Therefore, it is believed that the claims are allowable.

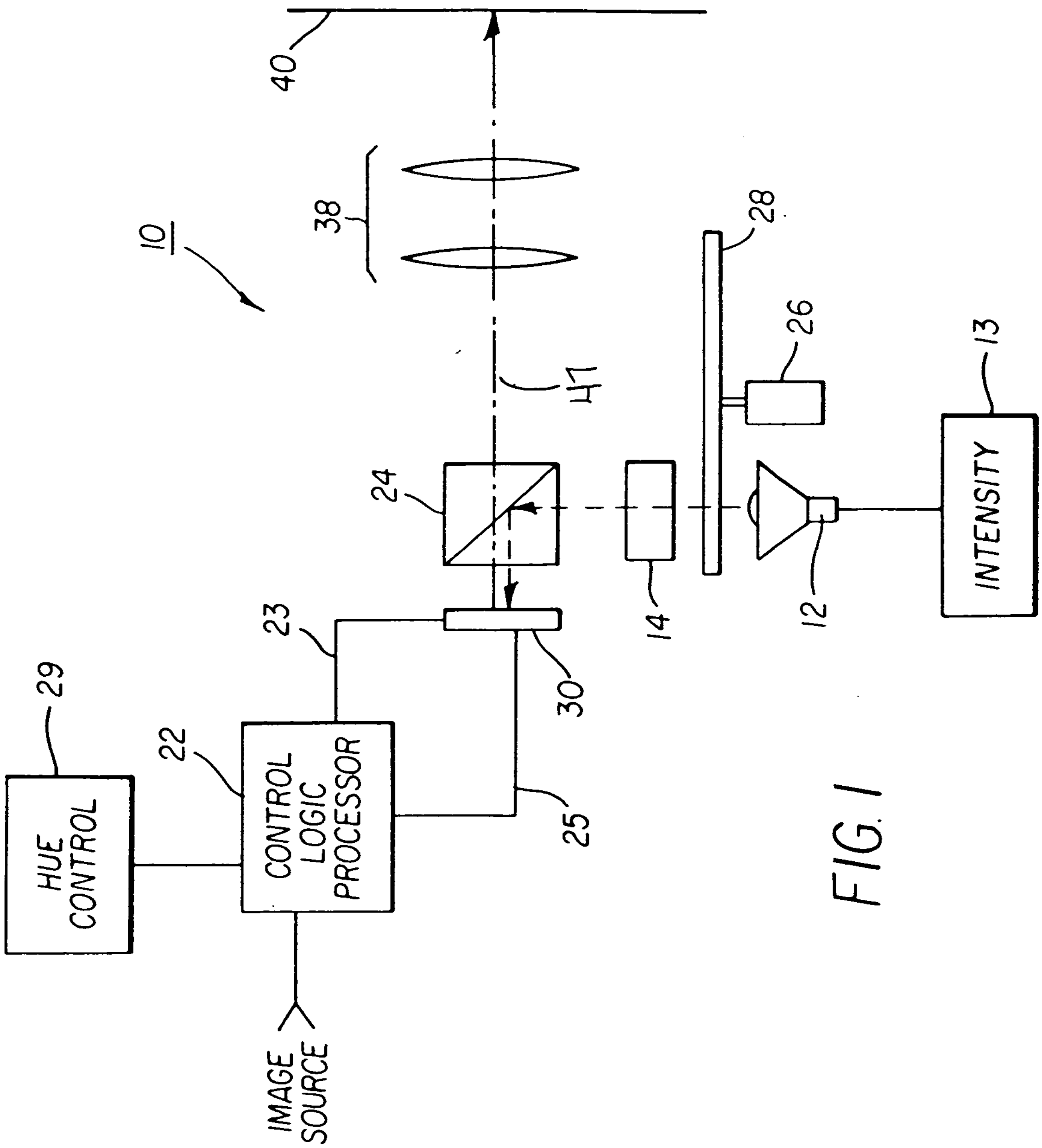
If the Examiner is of the opinion that additional modifications to the claims are necessary to place the application in condition for allowance, he is invited to contact Applicant's attorney at the number listed below for a telephone interview and Examiner's amendment.

Respectfully submitted,

Attorney for Applicant(s)
Registration No. 29,134

Nelson A. Blish/tmp
Rochester, NY 14650
Telephone: 585-588-2720
Facsimile: 585-477-4646

Enclosures: Replacement Figures 1 and 2
Annotated Sheets Showing Changes
Supplemental Disclosure Statement
PTO-1449 and copies of cited references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INTENSITY
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HUE CONTROL
CONTROL LOGIC PROCESSOR
25
IMAGE SOURCE

FIG. 1

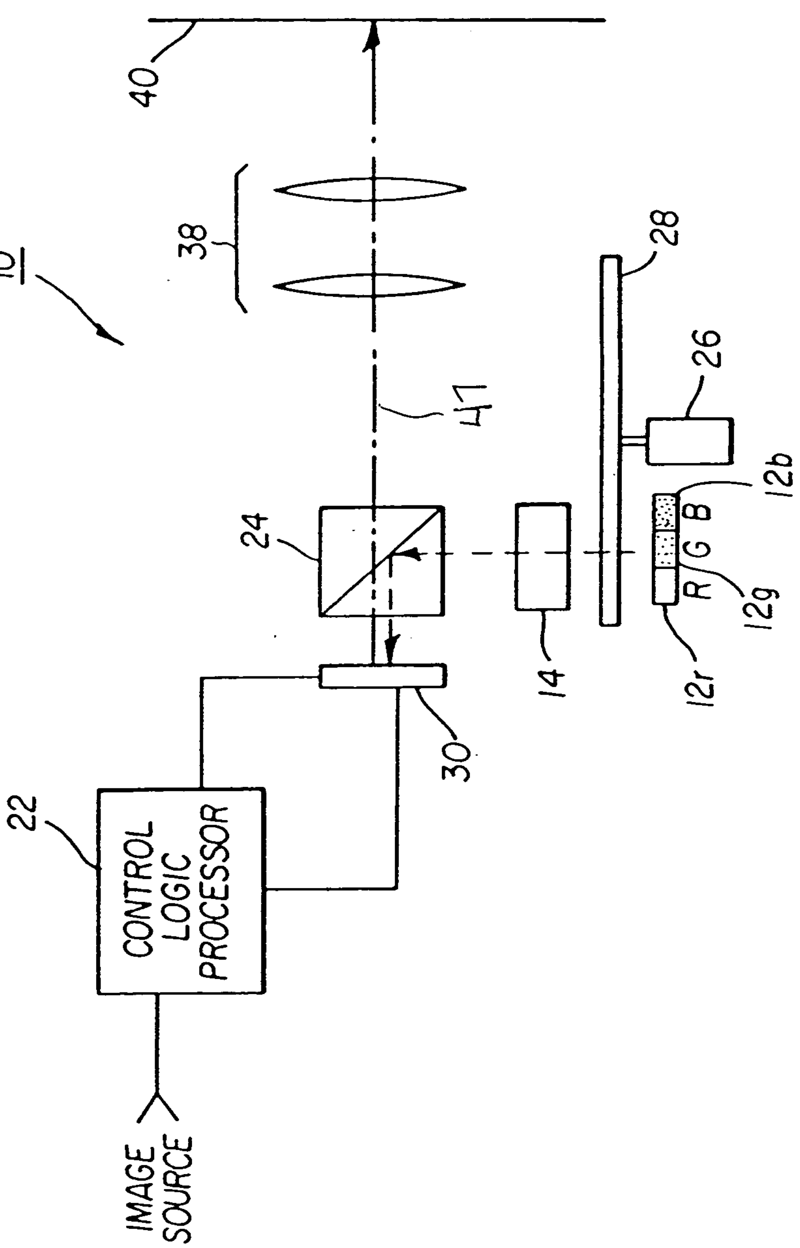
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FIG. 2